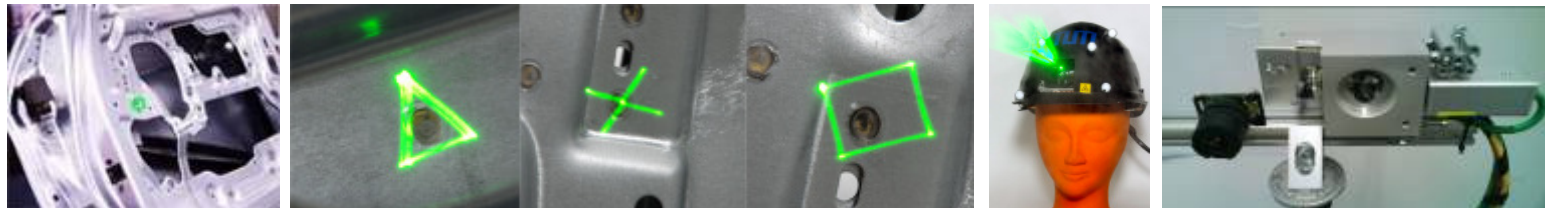


Using Laser Projectors for Augmented Reality

Björn Schwerdtfeger



Outline

- Applications
 - Quality assurance
 - Maintenance
- Problems
 - 1) Projecting on arbitrary surfaces
 - 2) Accuracy and sources of error
 - 3) Where to mount the projector
- Current system
 - Setup
 - Accuracy evaluation
- Summary

Applications 1: Quality Assurance in Series Production

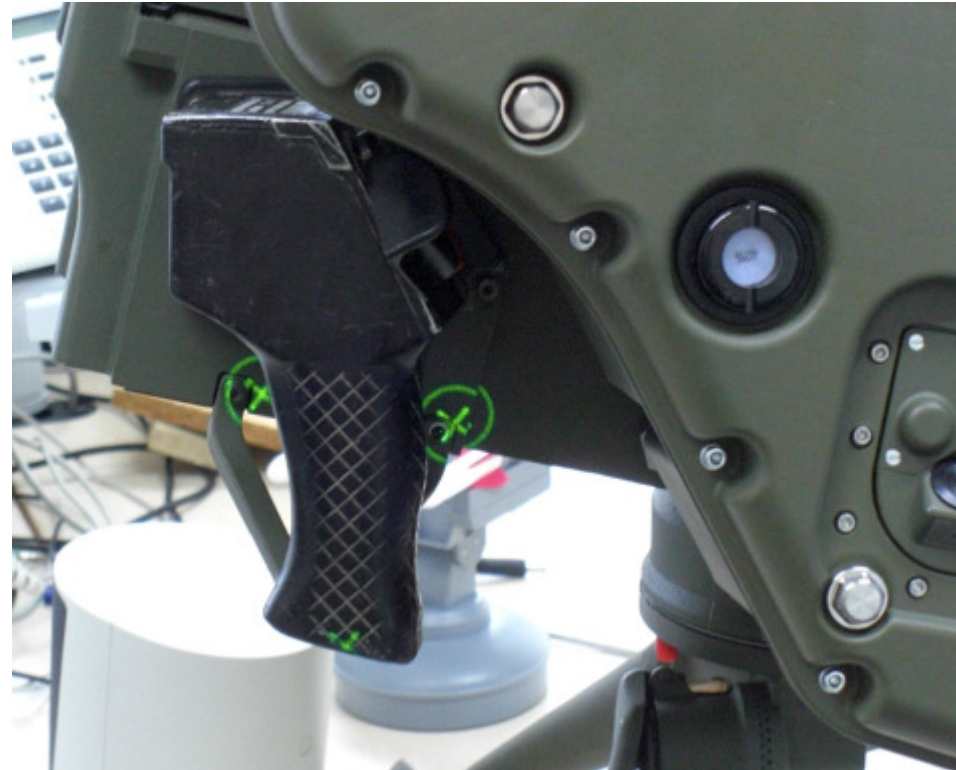
Inspection of welding points on white bodies



- E.g car doors
- Each 25th door
- Varying points (due to previous quality)
- Different methods of inspection
 - e.g viewing, ultrasound, destructive testing

Applications 2: Maintenance Support

- Display of the maintenance workflow
- Requirements
 - Mobile
 - Quick and easy set-up



Problems

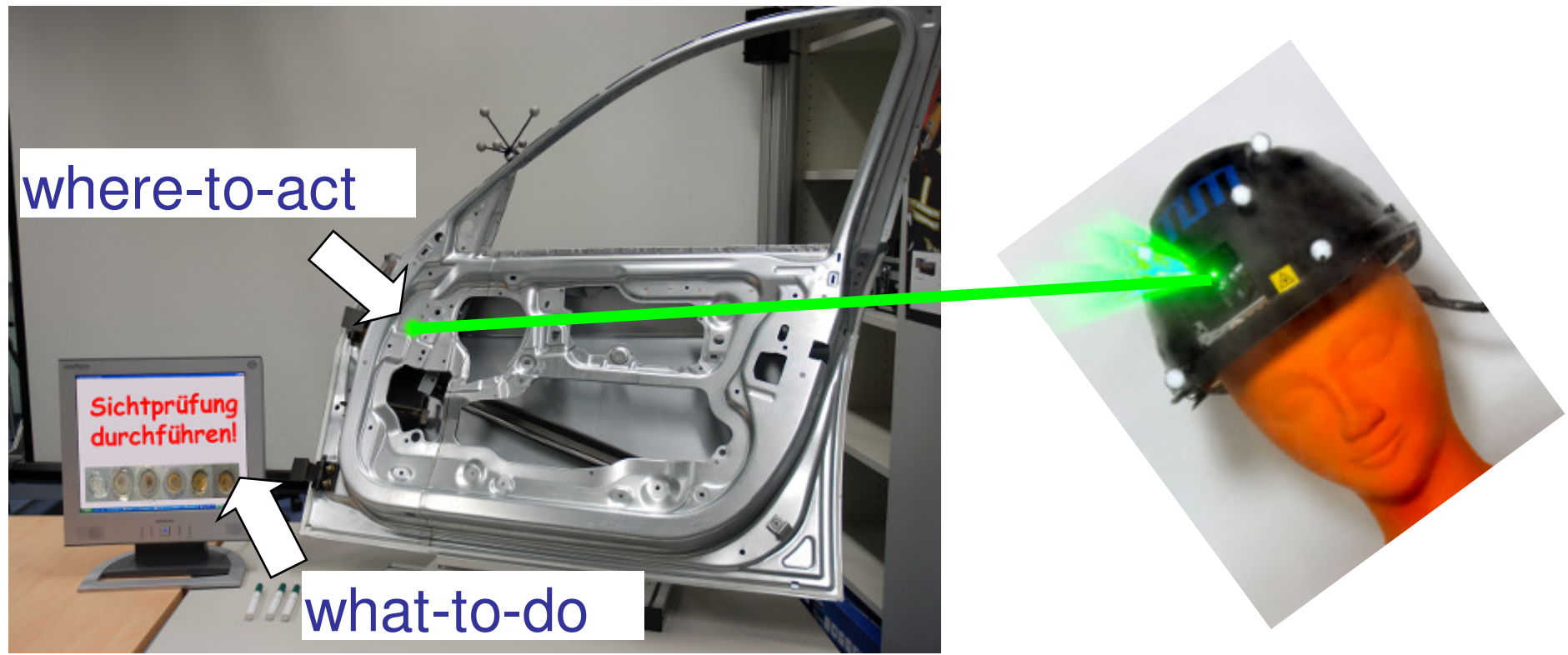
- 1) Projection on arbitrary surfaces
- 2) Accuracy and sources of error
- 3) Where to mount the projector

Problem: 1) Projection on Arbitrary Surfaces

- General
 - Requires presence of a surface
 - Public display
- Photometric and Optical
 - Bright illuminated workplaces
 - Metallic raw objects (e.g. white body)
 - reflecting light mainly in the specular direction
 - minimal amount of light is reflected omnidirectional towards arbitrary viewer positions
- Geometric issues
 - Deep dents, significant surface structure
 - Requires a pre-distorted projection



Problem: 1) Projection on Arbitrary Surfaces Hybride Display



Problem: 2) Accuracy and Sources of Error

- Accuracy depends on distance between projector and object rather than user and object
- E.g. 1 cm Accuracy required
 - projection distance 2 meters -> requires $5 \text{ mrad} \approx 0.3^\circ$
- Sources of error
 - Intrinsic calibration
 - Extrinsic calibration (tracking)
 - use inside-out (better rotation)
 - instead of outside-in (better translation)
 - Cheap laser scanners



Problem: 3) Where to Mount the Projector

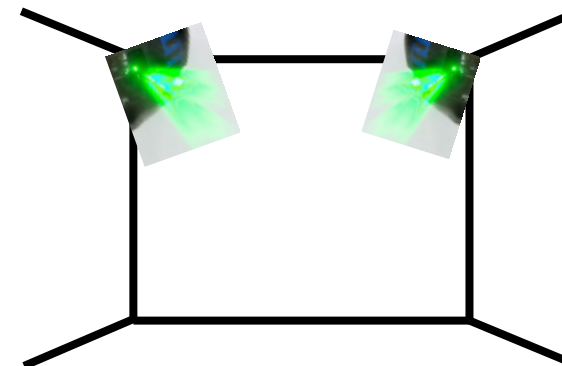
- Occlusion
 - By user (standing in the line of projection)
 - By object itself (protruding parts)

- Solutions
 - Optimized projector placement (next Slide)
 - Smart projection (not yet solved)



Problem: 3) Where to Mount the Projector

- Head/shoulder-mounted projector
 - Unlimited field of projection
 - No occlusion problems
 - Has to be light-weight
 - Accurate scanners are heavy
 - Needs accurate and fast tracking
 - Acceptability
- Room mounted
 - Slow but robust tracking
 - No weight limitations
 - Limited field of projection
 - Occlusion problem
 - Potentially expensive



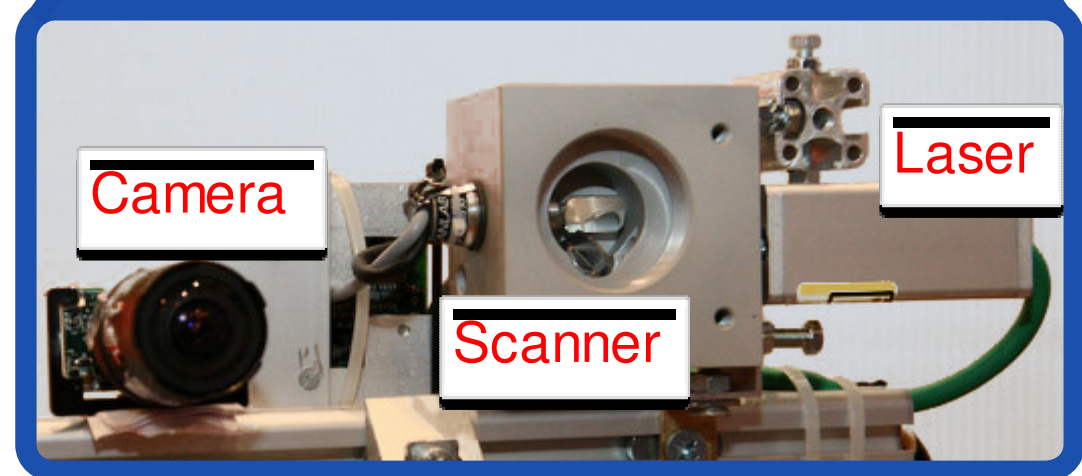
Current System

- Tripod mounted: balances some tradeoffs
- Still movable - reconfigurable
 - does not suffer from limited range of a room-mounted setup
- More weight possible
 - scanning
 - extra sensing hardware
- No fast tracking required



Current System

- Inside-out tracking
 - Theoretically better than outside-in
- Fish-eye camera
 - Tracked object always in Fields of view



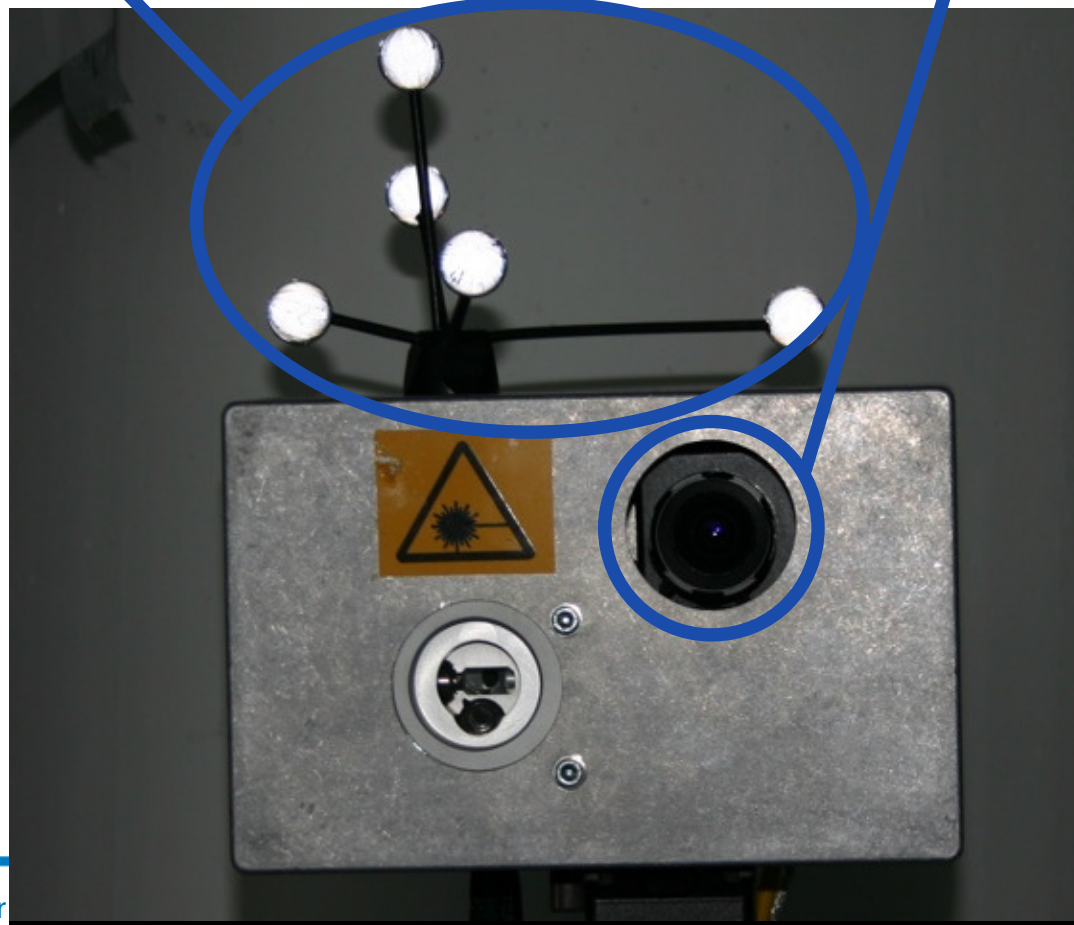
Current System: Accuracy Evaluation

Outside-In Tracking

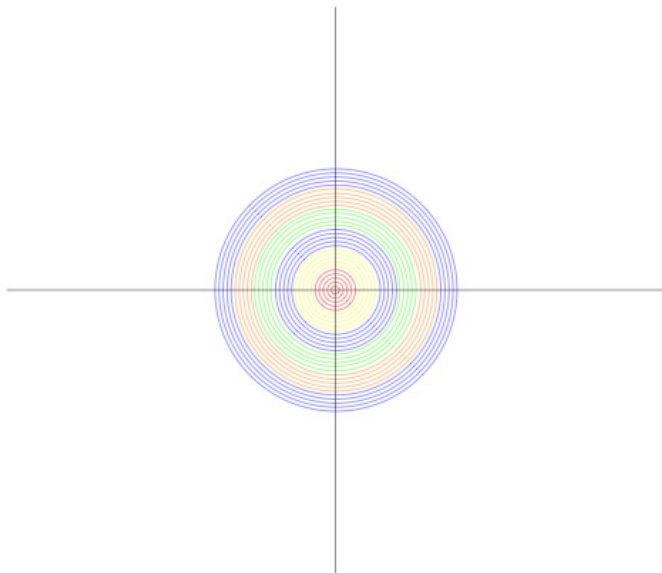
vs.

Inside-Out

Tracking

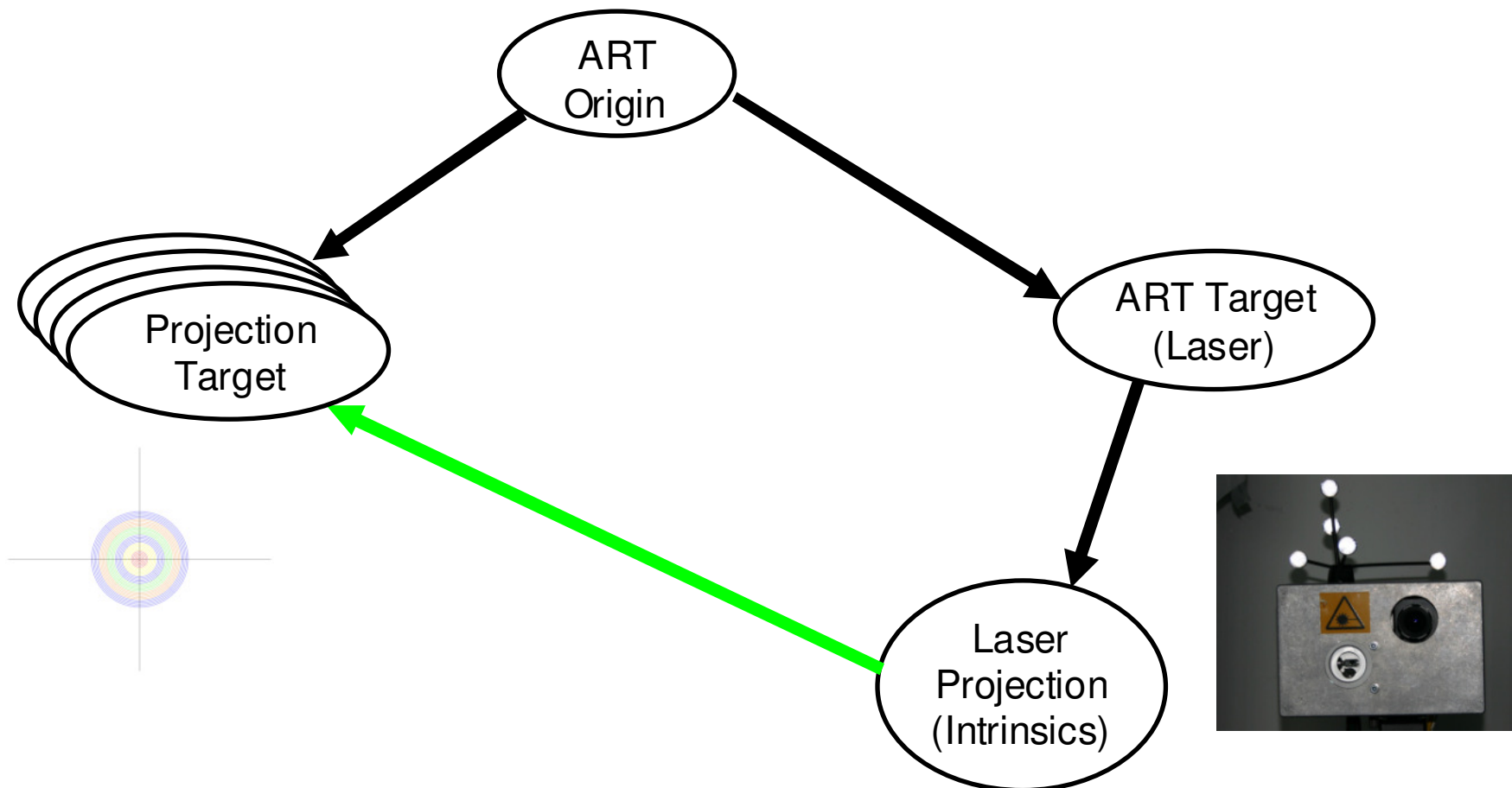


Current System: Accuracy Evaluation



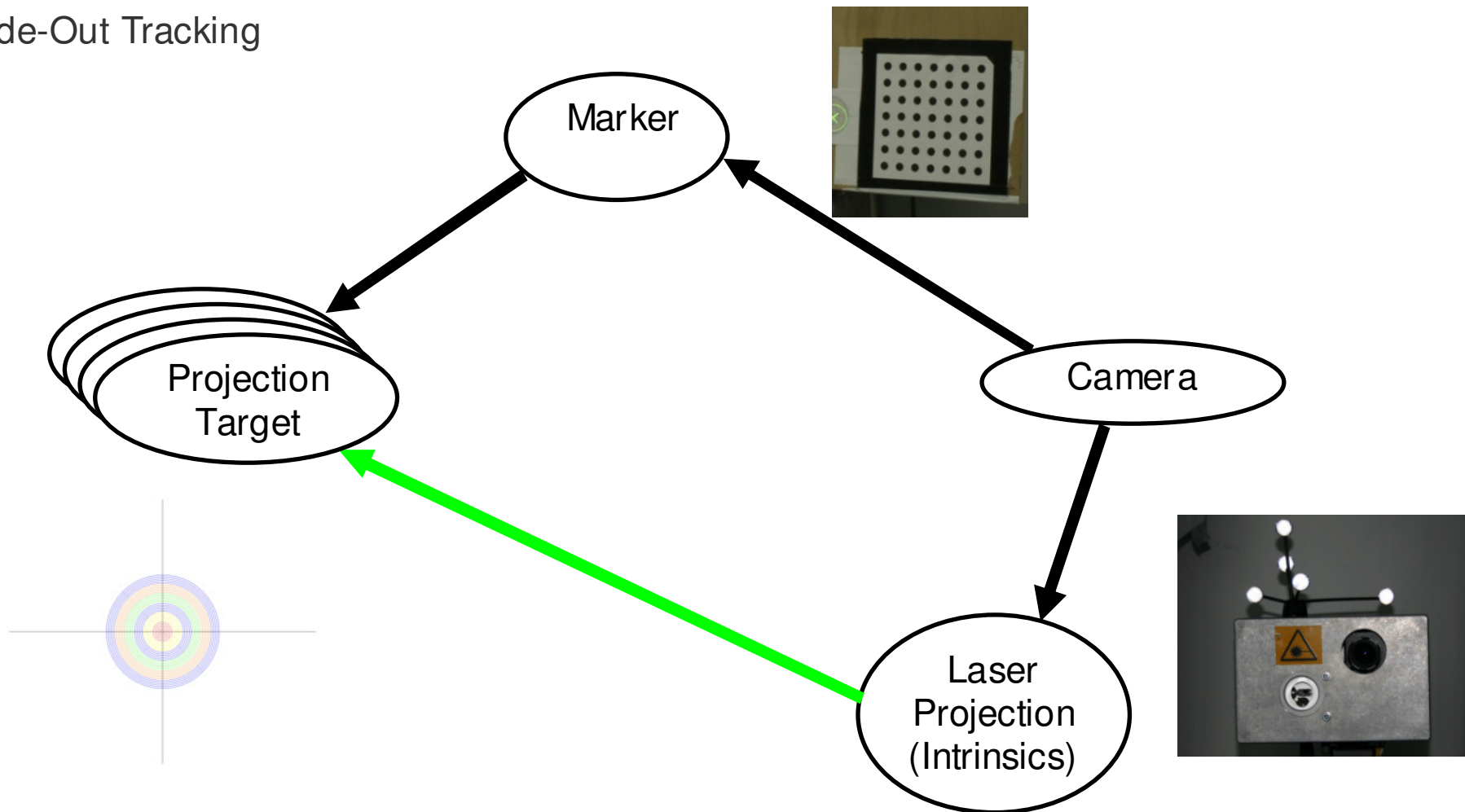
Current System: Accuracy Evaluation

Outside-In Tracking

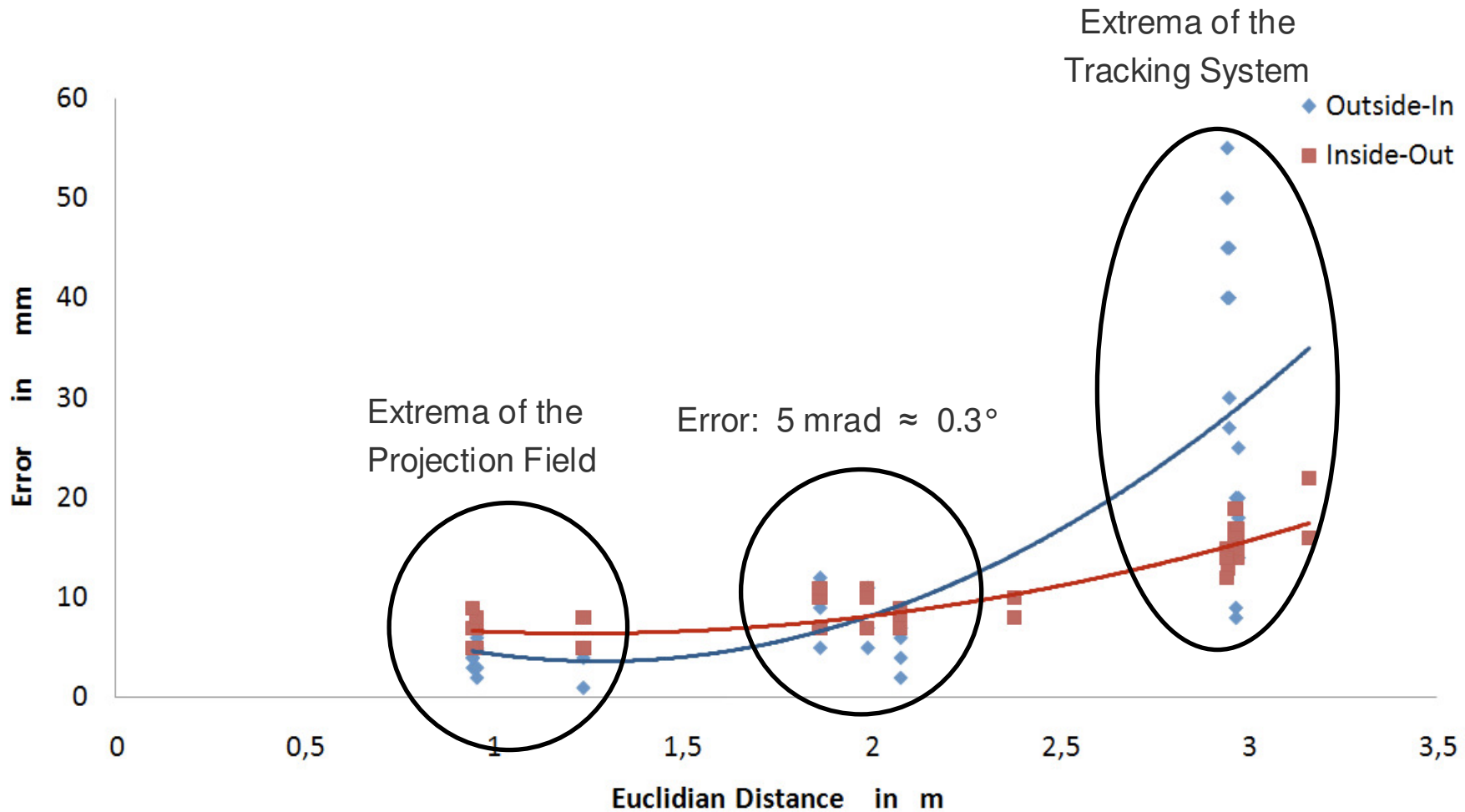


Current System: Accuracy Evaluation

Inside-Out Tracking



Current System: Accuracy Evaluation



Current System: Accuracy Evaluation

- Conclusion:
 - In theory
 - Inside-Out should outperform the Outside-In
 - In practice
 - having a large tracking area...
- A different setup will look different.... come and see it next door